



Armed Forces College of Medicine AFCM



Lecture Title

Glycogen metabolism

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Maher**

INTENDED LEARNING OBJECTIVES (ILO)



By the end of this lecture the student will be able to:

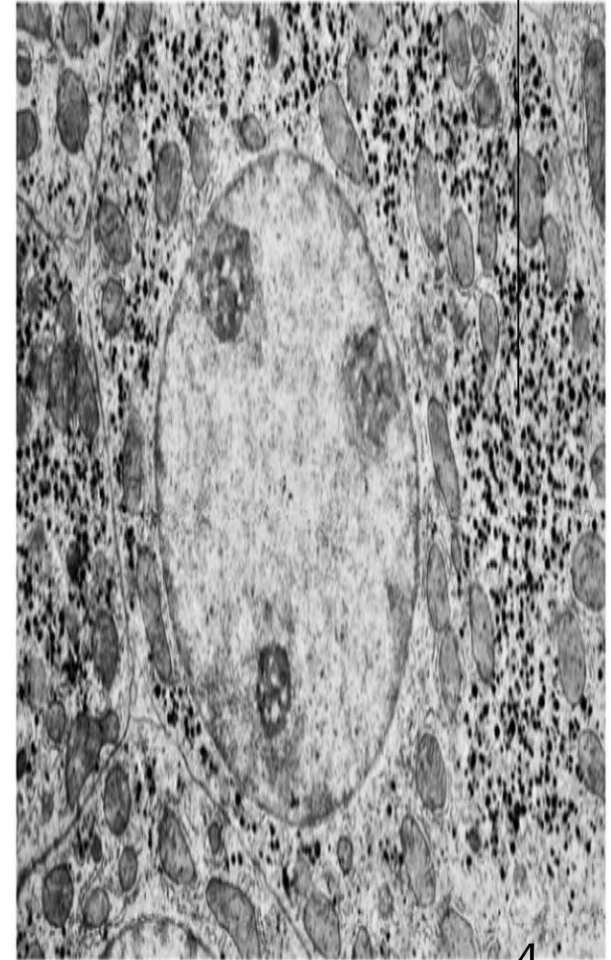
- 1- Illustrate the steps of glycogenesis and glycogenolysis
- 2- Demonstrate fate of glycogen in liver and muscle
- 3- Compare between liver and muscle glycogen

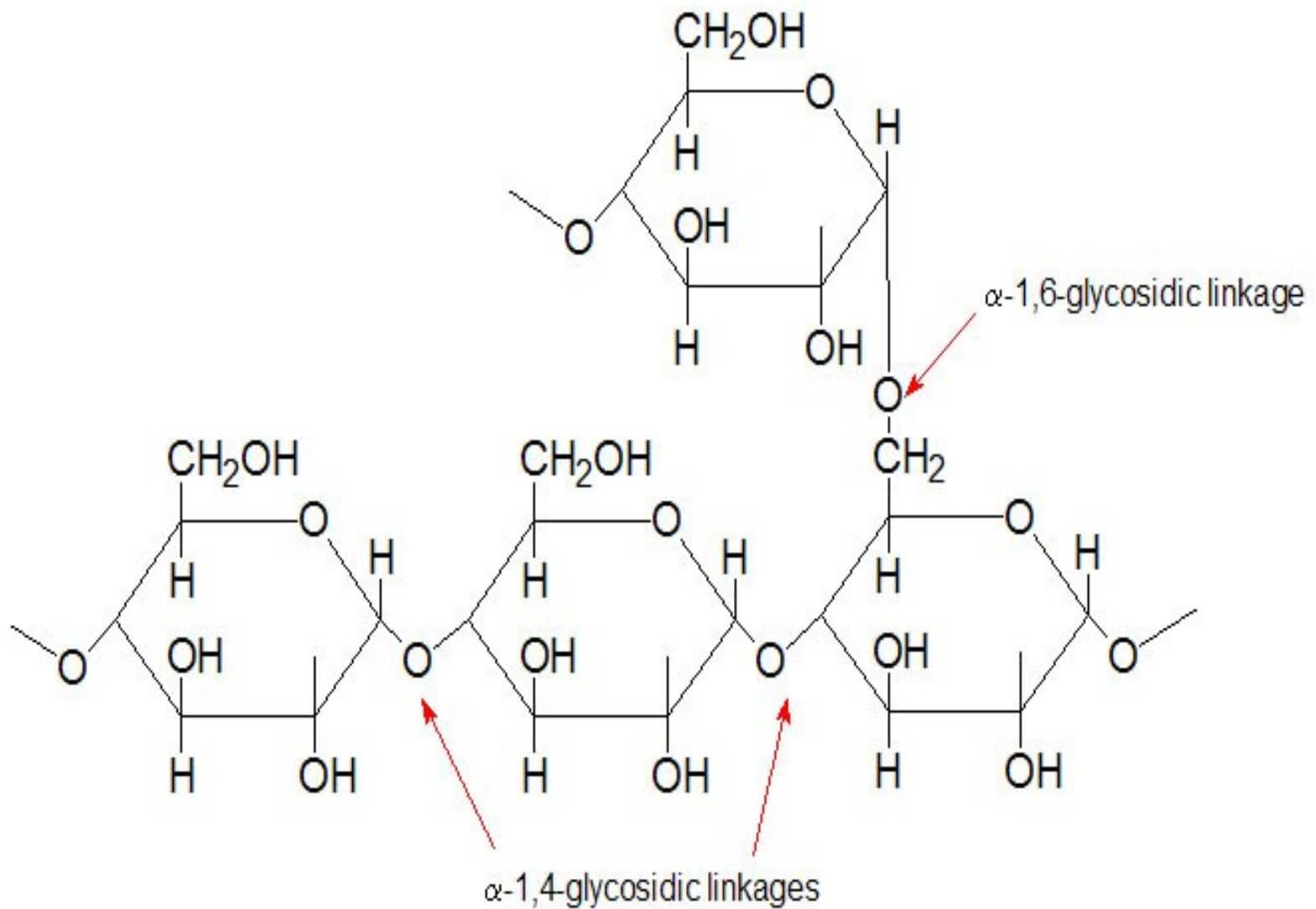
Glycogen



- It is the major **storage** form of carbohydrates in **animal tissue**.
- It is stored in the **cytosol** of every cell in the body as granules.
- It is specially **abundant** in the **liver (6%)** and **muscles (1%)**

Glycogen granules

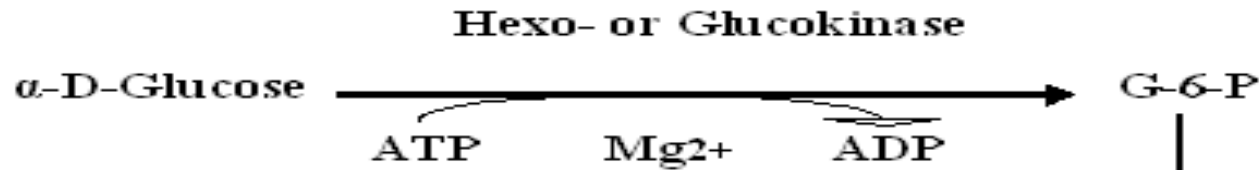




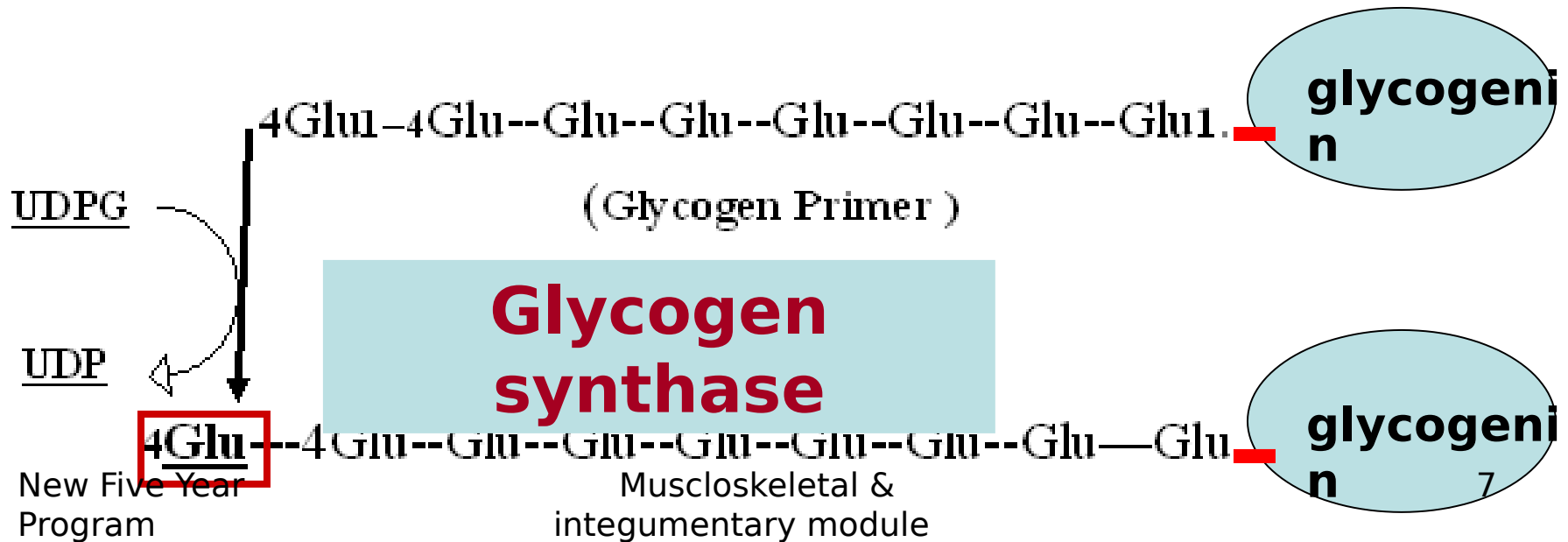
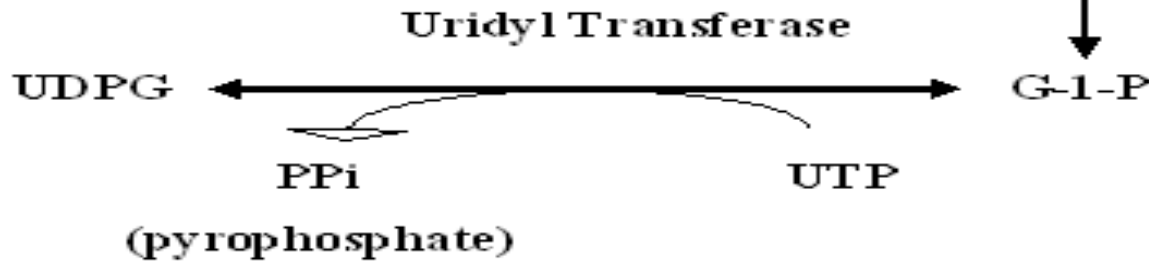


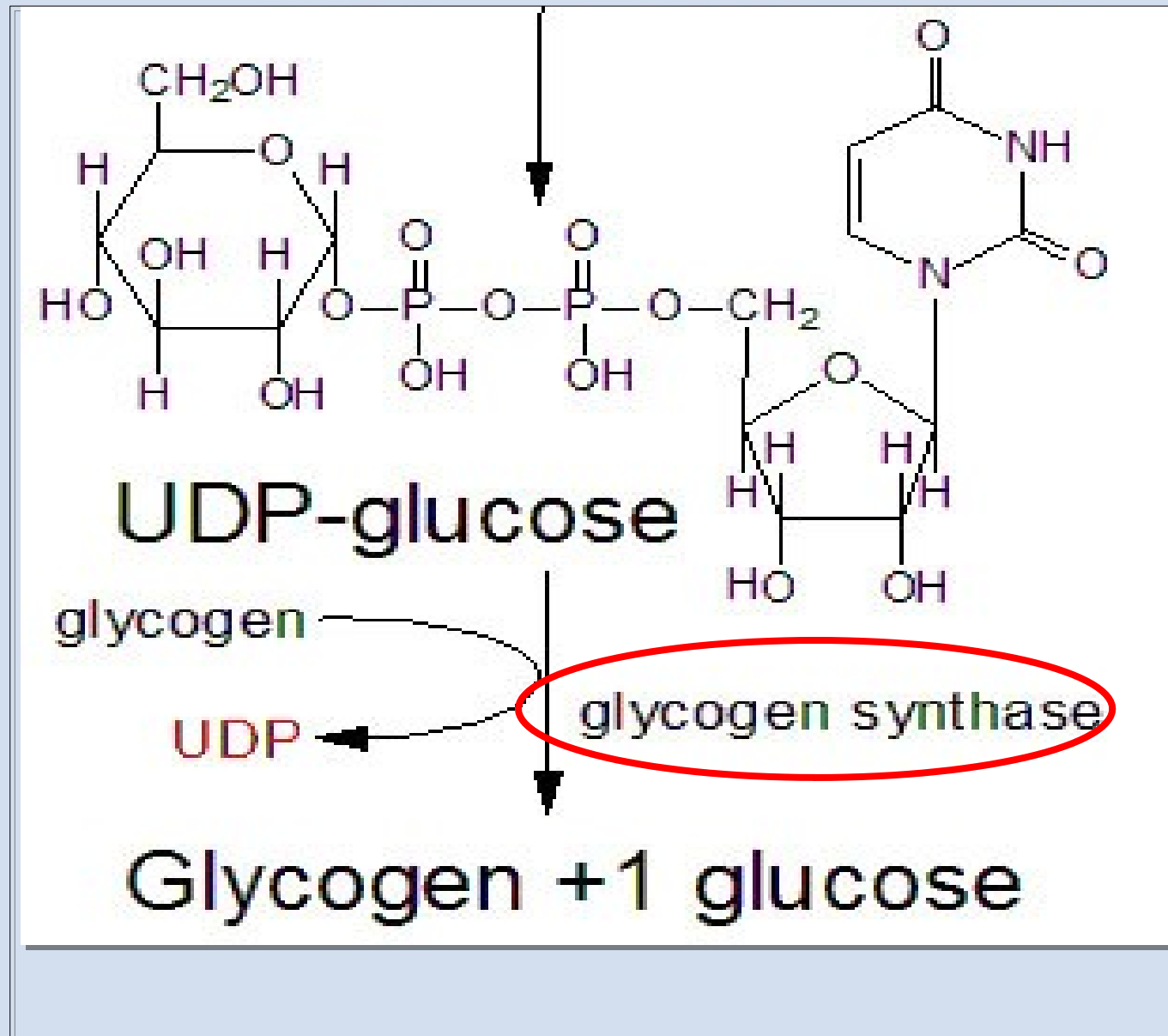
Glycogen Synthesis Glycogenesis

**Occurs mainly in the
Cytosol of
Liver and muscle
During well fed**



UDP-glucose pyrophosphorylase





Glycogen metabolism



- About **Glycogen primer** linked by α 1 -4 glucosidic linkages & -Attached to protein called **Glycogenin.**
- It is glycosylated by **UDP-Glucose**

Glycogen synthase



- Glycogen synthase is **key regulatory** enzyme of glycogenesis
- It catalyzes the transfer of **glucose** from **UDP - glucose** to the glycogen primer (C4).
- It forms only **α -1-4 glycosidic**

Branching Enzyme,

- Also known as amylo α -1,4 \rightarrow 1,6-transglucosidase.
- It transfers a part of the elongated chain (6-8 units) from the non-reducing end
- Attaches it to the C6 of the nearest chain creating a branching point by α -1,6-glucosidic linkage

UDP

Glycogen synthase
Several cycles

Glycogenin

Branching enzyme
 α 1-4 \rightarrow 1-6
transglucosidase

α - (1,6) branch linkage

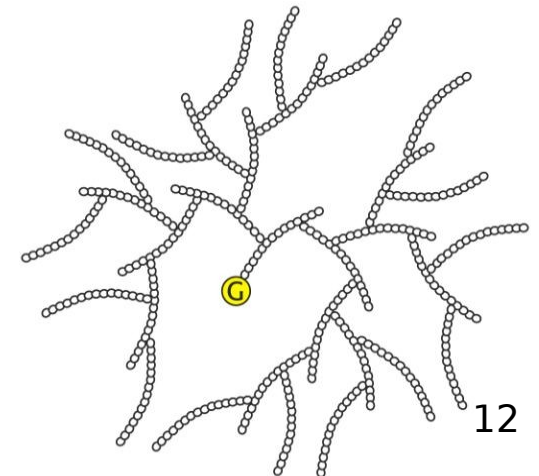
Glycogenin

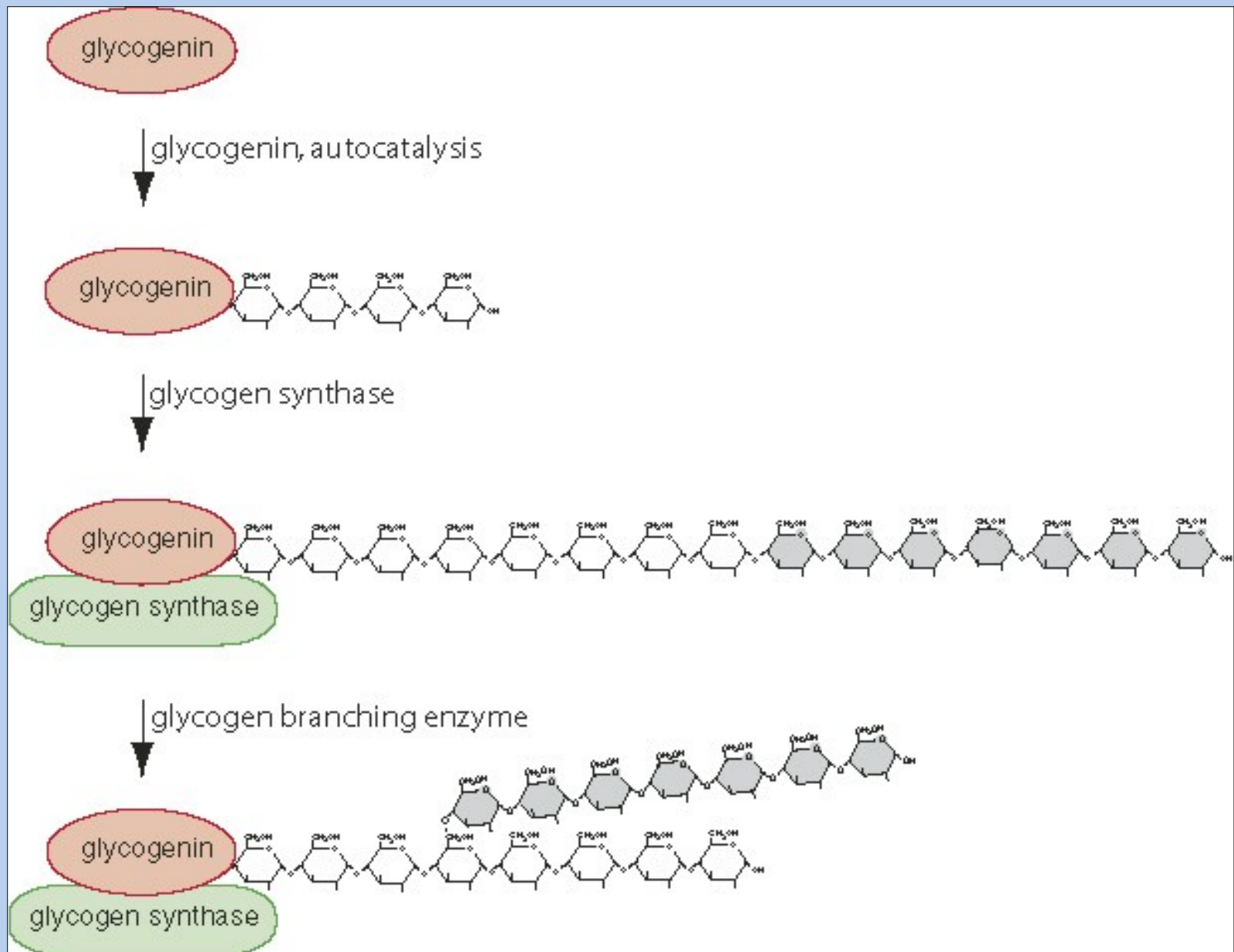
Glycogen synthase/
Branching enzyme
(several cycles)

UDP

Glycogen
Branch
Severs

UDP





Quiz



Which of the following is important for glycogenesis?

1. Glycogen phosphorylase
2. cAMP
3. Glucagons
- ④ glycogenin
5. Glycogen phosphorylase kinase

Glycogen metabolism



Glycogen catabolism

Glycogenolysis

**It occurs also in cytoplasm of
liver & muscle**

**Glycogenolysis proceeds
mainly in fasting (4 hrs after
last meal)**

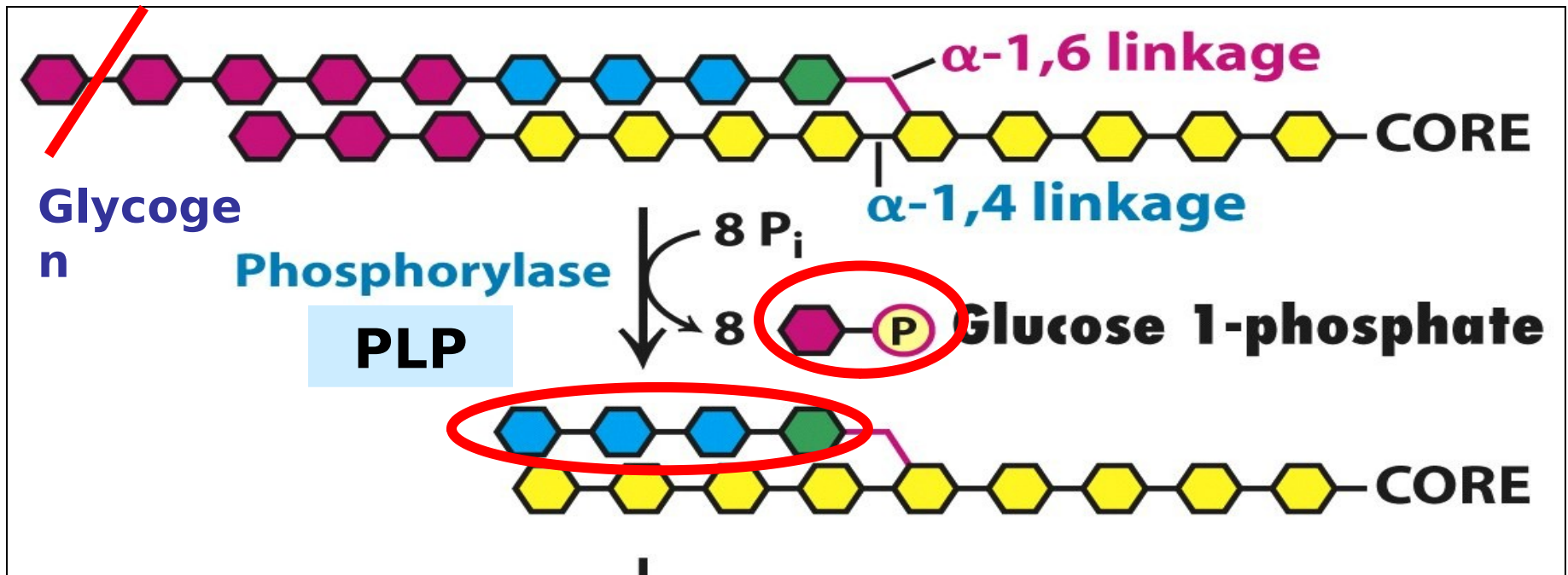
Glycogen Phosphorylase

- Key regulatory enzyme in glycogen breakdown
- Hydrolysis the α -1,4 glucosidic linkages & release glucose-1-P
- Removes glucose units from the ends of glycogen (C4).
- Phosphorylase contains **pyridoxal phosphate** as an integral coenzyme.

Glycogen metabolism



Glycogenolysis



Glucose -1-P



phosphoglucomutase

Glucose -6-P



Absent in muscle

Glucose-6-phosphatase

Glucose

Debranching enzyme



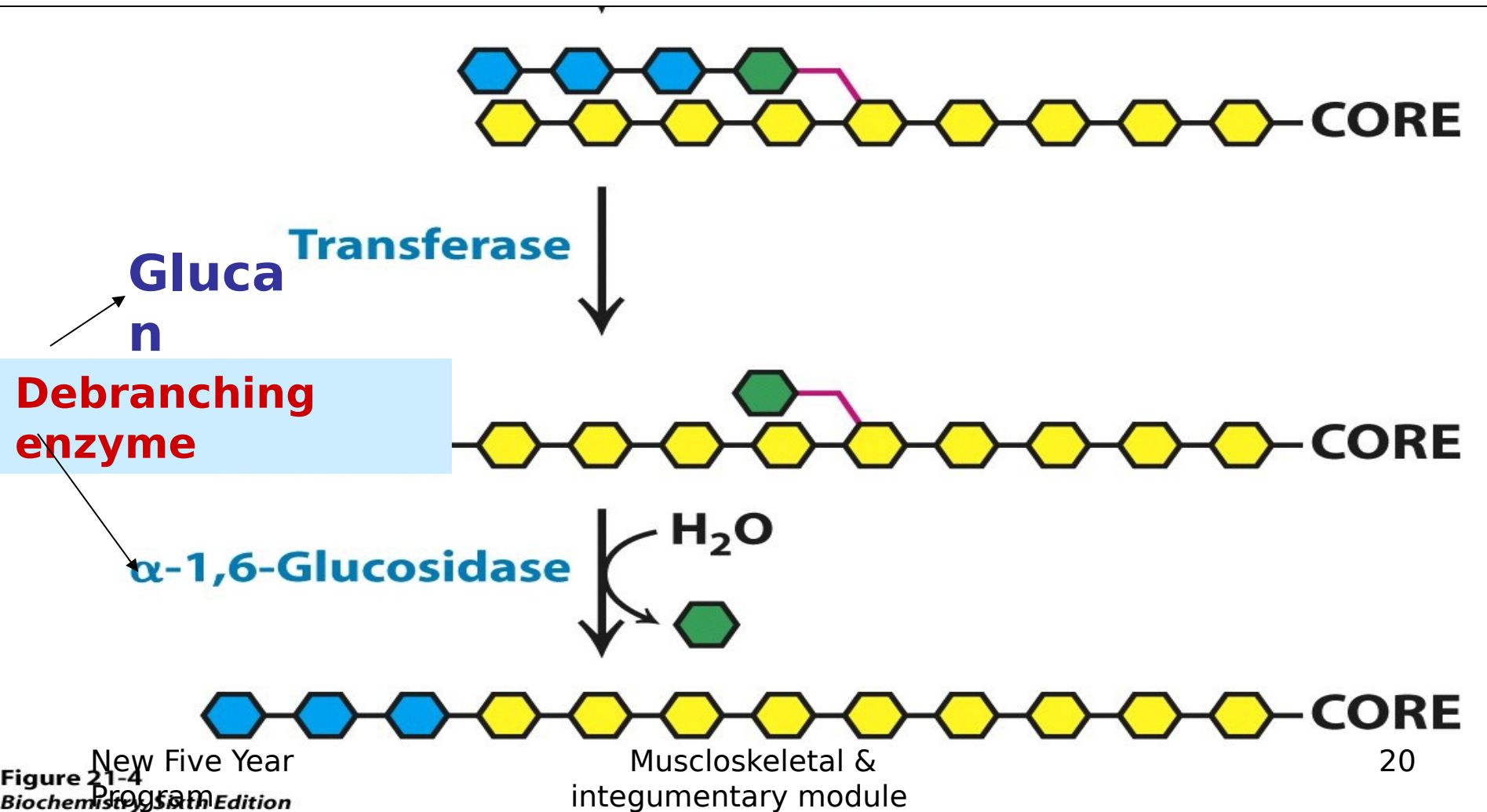
Glucan transferase,
transfers 3 units
from one branch to
the other leaving
the
 **α -1,6 glucosidic
linkage.**



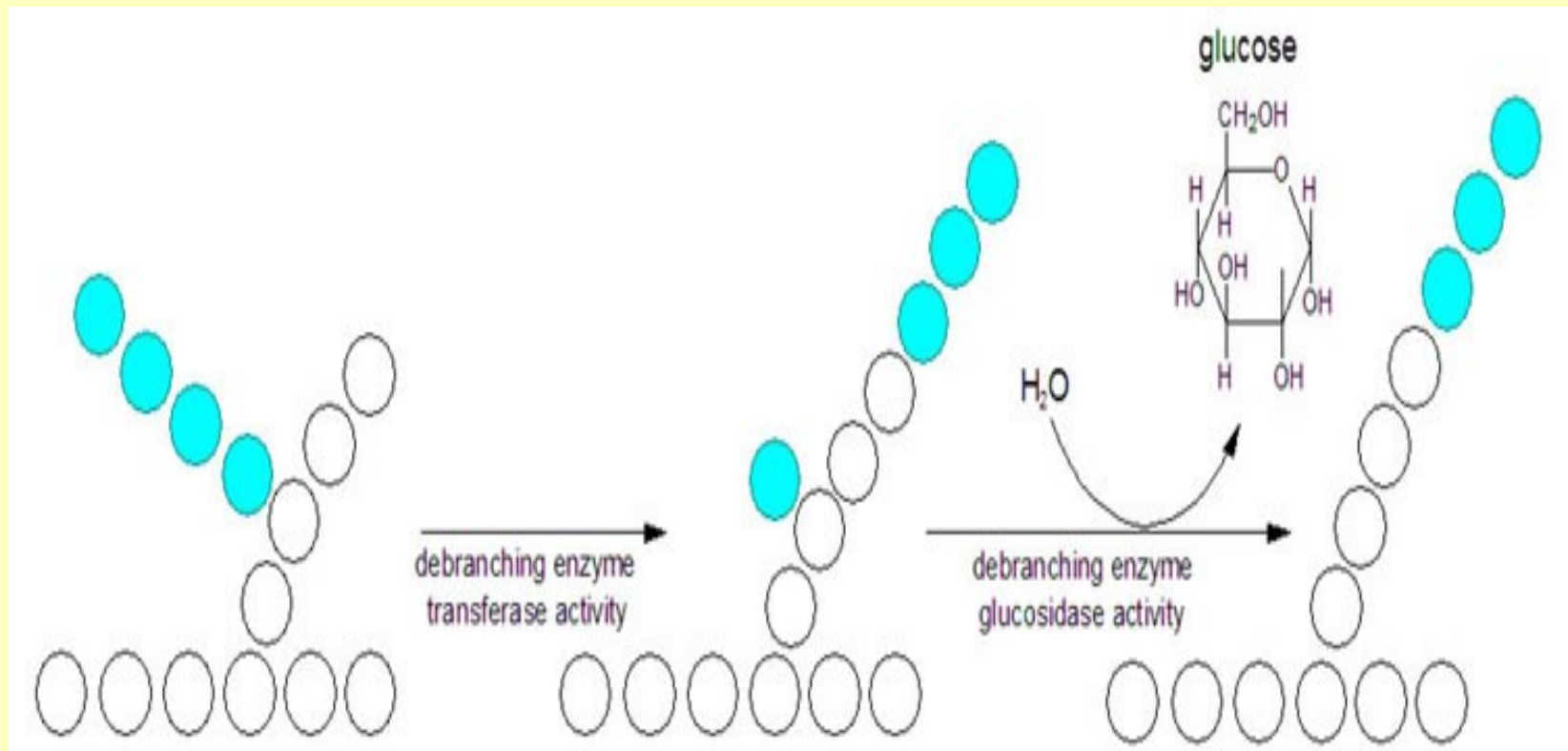
α -1,6
glucosidase
hydrolyses the
 α -1,6 glucosidic
linkage leading
to liberation of:
glucose

Glycogenolysis

<https://www.heckdiabetes.org/glycogenolysis/>

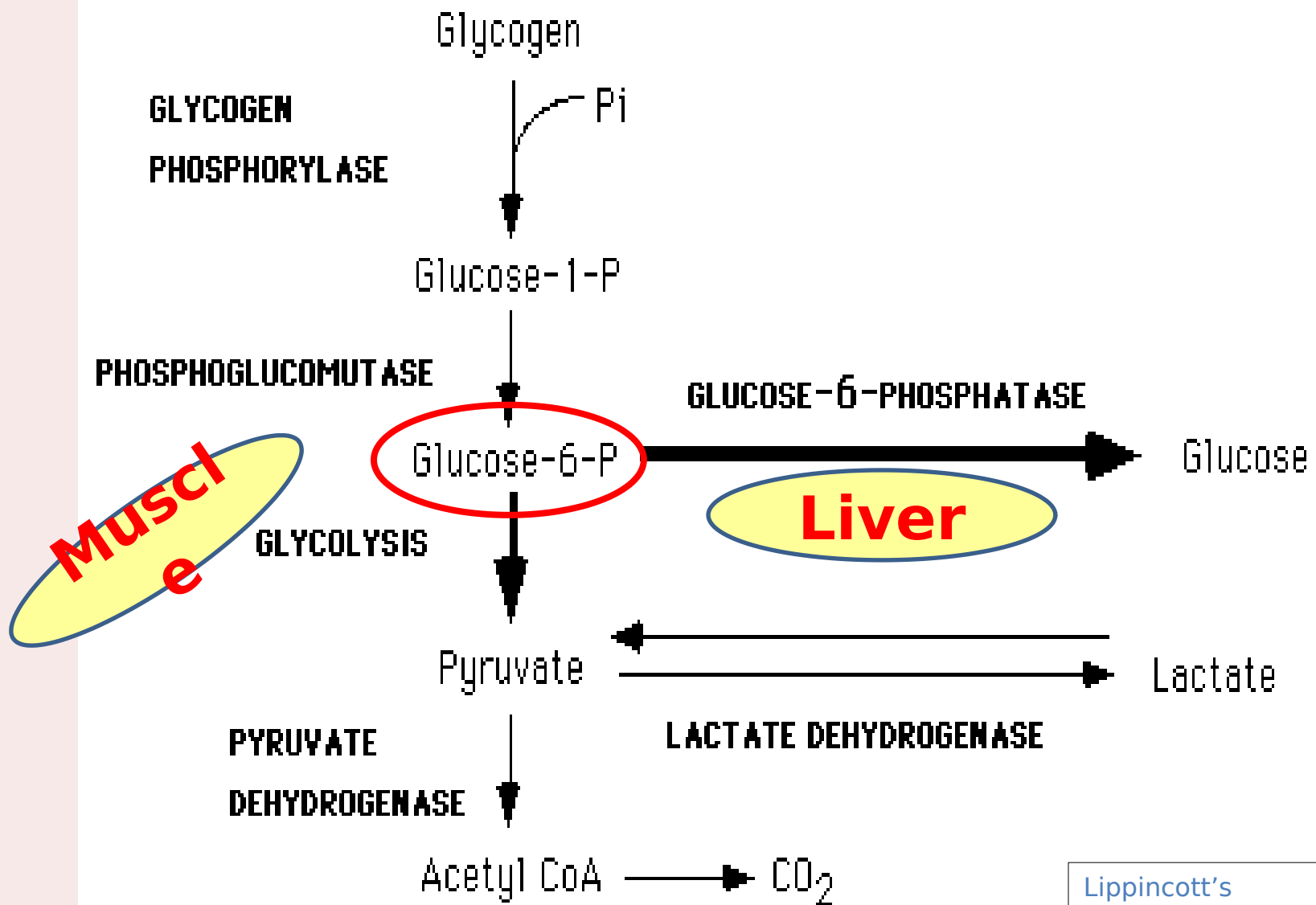


When the branch contains 4 glucose units, 3 of them are transferred to a next branch by transferase enzyme, leaving the last one.



- In the liver;
- glycogen is hydrolyzed to free glucose to maintain the blood glucose level required by many tissues.
- In the muscle:
- glycogen is hydrolyzed to G-6-P (why??) to be oxidized in glycolytic pathway to generate energy.

Fate of glycogen



Differences between liver glycogen and muscle glycogen:

| | Liver glycogen — | Muscle glycogen |
|--|---|--|
| Substrates | Glucose | Glucose |
| Amount | 120 gram | 350 gram |
| Concentration | 6 % | 1% |
| Functions | It maintains blood glucose concentration between meals | Private source of energy for muscle only |
| End product | Glucose | Lactate |
| Effect of hormone: 1. insulin 2. Epinephrine 3. Glucagon | Stimulates glycogenesis. Stimulates glycogenolysis. Stimulates glycogenolysis | Same Same No effect |

Quiz



- In **glycogen**, the chains are formed **α 1-4** glycosidic linkages while the branches are **α 1-6** glycosidic linkages.
- The active form of glucose in **glycogen synthesis** is **UDP Glucose**.
- The enzyme which removes the glucose residue at branch points of **glycogen breakdown** is **Debranching Enzyme**.

SUGGESTED TEXTBOOKS



- **References:**
- Lippincott's Illustrated Reviews- 6th edition.
- Harper's Illustrated Biochemistry-29th edition.

